

## Priorities for digital and artificial intelligence research in Horizon Europe



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# Priorities for digital and artificial intelligence research in Horizon Europe

## Introduction

In December 2022, the European Commission launched a consultation to define the priorities for Horizon Europe over the 2025–27 period. The second Strategic Plan will be instrumental in ensuring that EU research and innovation investment keeps targeting the achievement of the strategic objectives of the European Commission. It is also crucial that the new or renewed priorities are aligned with the current frontier of knowledge and address the challenges that have emerged since the publication of the first Strategic Plan,<sup>1</sup> such as those caused by the Russian war of aggression in Ukraine.

The present document updates [The Guild's proposals for strategic priorities for Horizon Europe's Cluster 4](#) published in 2019.<sup>2</sup> It presents our recommendations for strategic

orientations for digital research and the research areas where we recommend investment.

## 1. Key strategic orientations relevant to digital research

Horizon Europe's investment in collaborative and challenge-oriented research targets six clusters. One of them, Cluster 4 ("Digital, Industry and Space"), has digital research in its scope.<sup>3</sup> As per the first Horizon Europe Strategic Plan, this cluster makes the most significant contribution to two of the four key strategic orientations (KSOs): "promoting an open strategic autonomy by leading the development of key digital, enabling and emerging technologies, sectors and value chains" (KSO A); and "making Europe the first

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<sup>1</sup> European Commission (2021). *Horizon Europe: Strategic Plan 2021—2024*. Luxembourg: Publications Office of the European Union. DOI: 10.2777/083753.

<sup>2</sup> The Guild (2019) *Priorities for Horizon Europe's Digital, Industry and Space Cluster*. [https://www.the-guild.eu/news/2019/13\\_guild-priorities-for-horizon-europe-health-cluster.pdf](https://www.the-guild.eu/news/2019/13_guild-priorities-for-horizon-europe-health-cluster.pdf)

<sup>3</sup> Our present recommendations focus mainly on the following intervention areas covered by Cluster 4: advanced computing and Big Data; artificial intelligence and robotics; key digital technologies; and next-generation Internet.

digitally enabled circular, climate-neutral and sustainable economy” (KSO C).

These strategic orientations are still highly relevant and should be pursued under Horizon Europe’s second Strategic Plan with a greater emphasis on basic digital research and slight changes to some expected impacts.

Europe is still lagging behind China and the United States, among others, in terms of digital technologies, including digital platforms and social media companies, hence the importance of keeping the emphasis on strengthening Europe’s strategic autonomy. It is also crucial that the digital transition and green transition become even more intertwined. The new geopolitical context sheds light on the increasing need to invest in digital research to strengthen the resilience of our societies, technologies, and infrastructures against any threat of warfare.

## 2. Importance of investment in basic and frontier research in computer sciences

We recognise that digital technologies are enabling technologies. Their further advancement and adoption across the economy and society are required for them to enable various socio-economic challenges to be met, including the broad objectives of the European Commission mentioned above. The fast-paced digitalisation is underpinned by research and innovation activities investigating and developing new applications of digital technologies. However, the aim of Horizon Europe should not be limited to developing new technologies or improving incrementally existing ones (for instance, to apply new technologies in new domains or sectors). If the European Union is aiming to become a digitally enabled, competitive, resilient, and circular and

climate-neutral economy, it must invest in fundamental digital research to truly explore the unknown and find solutions that have neither been foreseen nor envisaged. For instance, we recommend that the European Commission maintain and even increase its investment in Artificial Intelligence (AI) network centres to exploit further their potential for pushing the knowledge frontier through support for cutting-edge research on AI.

Without the knowledge produced through fundamental and frontier-research projects, Europe will find it difficult to develop its own digital technologies and techniques, including AI systems. This will hinder its digitalisation and ultimately reduce its capacity to address pressing challenges and maintain (let alone strengthen) its global competitiveness. The sections below highlight both basic and applied research in which Horizon Europe must invest further over the period 2025–27 (and possibly beyond) to achieve these expected impacts.

## 3. New and renewed research priorities for digital research

The targeted impacts of Cluster 4 digital research under the Strategic Plan 2021–2024 remain relevant for the second part of Horizon Europe. However, certain research areas should be further supported to accelerate the achievement of these impacts.

### Maintain and improve Europe’s competitiveness and resilience

Through Horizon Europe’s second Strategic Plan, the European Union should invest further in research aimed at developing digital solutions for industry, as the global competitiveness of Europe still relies to a large extent on its capacity to develop, adopt and

implement cutting-edge digital technologies. Horizon Europe must therefore invest in digital research that will help businesses in Europe to remain globally competitive and resilient and even, where appropriate, to strengthen their global leading position. Considering the set of regulations in force (or about to be adopted) in the European Union to ensure a human-centred digitalisation (see below), Europe needs to invest more, including through Horizon Europe, than its competitors to enable the development of competitive digital technologies, techniques, and companies.

Research funded by Horizon Europe must support the servicification of primary and secondary industries, to increase their competitiveness and resilience. This can imply developing digital technologies and new applications (including software) to enable a strategic change in, and diversification of, their business models towards more services, where relevant and appropriate.

The Covid-19 pandemic and the new geopolitical context put Europe's supply of semiconductors at serious risk, jeopardising the resilience and competitiveness of its industries. Following an announcement in the 2021 State of the Union speech, the European Commission proposed a Chips Act<sup>4</sup> designed to mobilise research and innovation to create "a state-of-the-art European chip ecosystem" as well as to reinvigorate industrial competitiveness, strengthen resilience against shocks in global supply chains, and facilitate the twin green and digital transitions in Europe. Horizon Europe needs to contribute to these strategic objectives by investing in research that will make it faster to update existing software running on those chips that

are most likely to be affected by supply difficulties to Europe. In order to compensate promptly for such possibly disruptive changes, Europe will need swiftly to investigate and develop new software technologies. Research projects can also assist with automation in the porting of software between different hardware devices, as well as with software tools for verifying that the behaviour is preserved on the new platform.

### **Support the development of a human-centred digital economy**

Instead of focusing our efforts simply on the creation of global digital champions that could compete with the present US and Chinese market leaders, the primary objectives of investment through Horizon Europe's Cluster 4 must be to ensure Europe's strategic autonomy and resilience and to develop a digital economy in compliance with its fundamental values. The European Union must focus on the development of its own approach to digitalisation (human-centred and rooted in EU common values) rather than on attempting solely to gain superiority over its more advanced Chinese and US competitors.

This calls for research into the development of software that enables a gradual transition towards autonomy where the human operators have control and can be involved in the decisions on when to move to new levels of autonomy. There is also a need for additional research in software technologies that investigate new ways of interacting with physical devices.

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<sup>4</sup> European Commission (2022). Proposal for a Regulation of the European Parliament and of the Council establishing a framework of measures for strengthening Europe's semiconductor ecosystem (Chips Act). COM (2022) 46 final.

## Enable the emergence of a data economy

Horizon Europe must keep investing in research for the development of world-leading data and computing technologies and to ultimately enable a globally attractive, secure, and dynamic data-agile economy. There should also be further support for exploring and developing probabilistic programming.

Public investment is needed to support basic research on data quality, data architecture and solutions enabling increased and safer use of sensitive data. This will facilitate and increase data flows and foster the emergence of a data economy in Europe. Progress is needed in technologies and techniques used to manage massive datasets, in order to enable fundamental research on, and further development of, machine learning and AI systems. Research is especially needed to help cope with massive amounts of data and to create value from it. This is primarily a matter of having the right computer science skills and of strengthening capabilities for the efficient gathering and storing of huge amounts of data from many different fields, and for searching and analysing this data. Horizon Europe must also fund research aimed at supporting the creation of common data spaces and the European Open Science Cloud (EOSC), as part of the European Strategy for Data<sup>5</sup> to facilitate data flows.

Moreover, it is crucial to invest in research on potential data solutions in order to investigate not only their compliance with privacy rules and fundamental values in Europe, but also their effectiveness in still allowing rigorous data analyses. Likewise, research aimed at the development of European standards for the

collection, storage, and curation of data and datasets would be of high EU-added value, as such initiatives are still fragmented across Europe.

The emergence of Big Data raised expectations that for many challenges and problems, data would be available. The reality is that despite the fast collection of massive amounts of data on human-generated and natural phenomena, it is often still insufficient to remedy many issues, such as social inequalities, access to housing and healthcare, employment, logistics, preservation and management of resources, or climate change.

Also, there is still a long way to go from data collection to making inroads into the 17 United Nations Sustainable Development Objectives. The European Union has committed to significant investment in creating common data spaces. However, because of many administrative regulations, the granularity of the data and its integration are both still inadequate. Horizon Europe must help to bridge the gap between the algorithms of privacy-preserving data mining, secure multi-party computation and data analysis, and enable the use of these algorithms to extract effective information and analytical intelligence that might serve to impact all sorts of social, industrial, and environmental targets.

## Intertwine further the green and digital transitions

The second Strategic Plan of Horizon Europe must tap into the potential of the digital transition to accelerate the green transition. On the one hand, it implies maintaining investment in the discovery and development

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<sup>5</sup> European Commission (2020). A European strategy for data. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. COM(2022) 66 final.

of solutions for a more resource-efficient economy in Europe. For instance, Horizon Europe must help improve energy management in the context of increasing numbers of energy sources and (small) producers. Balancing the energy grid requires interdisciplinary research including at least control, software, business, and optimisation capabilities.

The exploitation of Big Data spaces can assist with the monitoring and tracking of energy footprints at the level of both individuals and organisations so that anyone is able to monitor their own energy footprint and environmental impact. This will enable all individuals and organisations to be informed, to assess their individual and collective activities and behaviour against benchmarks, and to act responsibly towards environmental targets.

Despite Big Data, it remains extremely hard to identify the most energy-efficient behaviours, especially when all medium- and long-term factors are considered. It will therefore be extremely important and highly relevant to promote research into helping the formulation – based on massive datasets of high granularity – of individual recommendations on how to act more responsibly with respect to the green transition. This research will nevertheless need to ensure the privacy and security of all data.

On the other hand, the twin transition requires that digital technologies should not contribute to increasing the consumption of materials and energy. Investment in basic digital research will therefore need an increased emphasis on solutions for accelerating the green transition of these technologies to ensure that the digital technologies are competitive and fit for the Green Deal. This could be achieved by

exploring how to improve the resource efficiency and recyclability of technologies (e.g. computers, including high-performance ones) and their components (e.g. chips).

Horizon Europe must invest in research into digital passports for product components. This passport would be a prerequisite for establishing take-back programmes – as part of broader circular economy strategies – for Europe-manufactured products, and for enabling their remanufacturing. This needs to be interdisciplinary research coupling software capabilities, for example using blockchains.

Likewise, Horizon Europe should finance projects aimed at reducing the energy consumption of data transfers and storage and at exploring how the heat produced by digital technologies and operations could be re-used to contribute to circular processes. Other relevant research areas include neuromorphic computing and the evaluation of energy consumption by software.

### **Improve public services and governance through digital technologies**

Beyond Cluster 4, Horizon Europe must invest in digital research aimed at strengthening democracy and improving the functioning of public institutions. Digital technologies may be able to support policymaking, to help nudge specific behaviours, and to support citizen engagement in decision-making (e.g., through the development of participatory platforms, including for the purpose of facilitating citizen science), thereby strengthening democratic governance. For instance, AI solutions can reduce – or even remove – human biases in judgement and therefore increase trustworthiness in the justice system.



Horizon Europe must support research aimed at enhancing data spaces with the analytical capabilities of machine learning, data mining, knowledge discovery, and AI to bolster knowledge discovery and enable individuals and organisations to gain crucial actionable intelligence towards informed decision-making. This will equip participants to discuss policies and public decisions based on thorough information, and to achieve consensus in a genuinely democratic way, listening and learning from each other. Any agreement reached would be backed by detailed evidence. Individuals and organisations would then be more likely to be convinced of, and highly engaged with, public decisions as they could participate in the underlying discussions and agreements. Their ownership of public decisions – improved through digital technologies – would, in sum, strengthen democratic governance.

Likewise, public investment is needed in research and innovation projects to facilitate and accelerate the use of data in public administration. For instance, huge efficiency gains could be obtained in the administration and management of, for instance, mobility (transportation) and health services. Horizon Europe must contribute to increasing the capacity of public administration bodies to anticipate and plan in the very short, medium, and long term with comprehensive data sets. This will result in huge improvements in the provision and sustainability of public services.

### **Leverage the potential of digital technologies in education**

Digital research can also contribute to the objective of strengthening social and economic resilience by investigating the use

of digital technologies in education. The Covid-19 pandemic provided universities with opportunities to reflect on the potential of digital tools for education. It also demonstrated the need and value of physical learning experience as the bedrock of European public higher education, hence the importance of developing [creative blended models for teaching](#) that can tap into the potential of digital technologies without undermining the importance of face-to-face and on-campus classes.<sup>6</sup> Digital tools can assist with faster learning of foreign languages, improving access for minorities – including refugees – and developing personalised education. Horizon Europe should support research exploring the use of new technologies in the educational sector, while ensuring different languages will be supported in order to ensure that the education system is fair for all stakeholders.

Education contributes to increasing productivity and wealth, resulting in higher living standards and economic sustainability. It also has great potential for promoting social and democratic values and therefore strengthening democratic governance. Horizon Europe must address, through its investment in research and innovation activities, the need to re-establish public trust in data, and in the information that underpins public decision-making, as well as in the sources of both the data and the information. There need to be closer links between education and research so that students can strengthen their critical abilities and learn how to beware of texts, images, sounds, and videos created by AI technologies, and which are increasingly difficult to distinguish from

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<sup>6</sup> Angouri, J. (2021). Reimagining Research-led Education in a Digital Age. The Guild Insight Paper No. 3. The Guild of European Research-Intensive Universities and Bern Open Publishing. DOI: 10.48350/156297.

those genuinely produced or composed by humans.

### **Increase Europe's security**

The war in Ukraine increased the risks of cyberattacks and disinformation campaigns (especially through social media and other online platforms) aiming to weaken democracy across Europe. Horizon Europe will therefore need to put more emphasis on the contribution of digital research to creating a more resilient, inclusive, and democratic European society (KSO D), and on investing, for instance, in research that helps to fight disinformation and increase Europe's security against cyberattacks. This implies stronger synergies between Cluster 4 and both Cluster 2 (to support actions in favour of democracy, its stability and further development) and Cluster 3 (to increase Europe's resilience against external threats including cyberattacks).

There is a need for research in cybersecurity at many levels, including cryptography and defence against attacks at all levels ranging from hardware IoT devices up to the cloud. With increased intelligence in systems, the attack surfaces are generally increased and thus research is needed to improve the capacity to mitigate these risks and to protect the desired behaviour and data of the systems against attackers.

Both digital and green transitions imply a heavy reliance on highly connected global computer networking infrastructures. This increases Europe's vulnerability as these infrastructures are likely to be targets for attack. Horizon Europe must therefore ensure that the twin transition integrates all levels of cybersecurity and its derivatives (reliability, integrity, non-repudiation, etc) and that all essential infrastructures are secured by cutting-edge systems and technologies. Such

research is crucial as the digital transition relies on the trustworthiness and reliability of the underlying digital infrastructure.

## **4. Funding instruments for digital research**

As digital technologies are often used as enabling technologies applicable in multiple and very diverse sectors and areas, Horizon Europe must put a strong emphasis on interdisciplinarity. This implies not only addressing the same research questions through different disciplinary perspectives but also encouraging multidisciplinary consortia and ensuring that proposals are evaluated by diverse evaluators experienced in the evaluation of such projects. So far, the interdisciplinary nature of research projects has not been systematically reflected in the composition of the consortia. For instance, AI researchers are not always involved in projects about the use of AI technologies in specific areas. However, the combination of domain- and machine-learning expertise is especially important in developing relevant algorithms, especially for what is called physics-informed deep learning.

Despite the strong emphasis on the development of enabling digital technologies and solutions, Horizon Europe must allow more for long-term fundamental research and high-risk research. Such basic research does not systematically need to be interdisciplinary. It may instead focus on digital research and computer sciences to allow progress specifically in these fields without the immediate prospect of applications in other domains or sectors.



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